Novel uses of RadioFrequency ablation

Dr.J.Lane

Monthly Pain Rounds

May 26th , 2011.

Practice Guidelines for Chronic Pain Management

- Systematically developed recommendations
- Assist the practitioner and patient in making decisions about health care
- Recommendations may be adopted, modified, or rejected according to clinical needs and constraints
- ***Not intended*** to replace local institutional policies
- Their use cannot guarantee any specific outcome
- "Provide basic recommendations,supported by synthesis and analysis of the current literature,expert and practitioner opinion, open forum commentary, and clinical feasibility data.."

An Updated Report by the American Society of Anesthesiologists Task Force on Chronic Pain Management and the American Society of Regional Anesthesia and Pain Medicine. Anesthesiology 2010; 112:810 –33

Ablative Techniques- Radiofrequency ablation

- Conventional (e.g., 80 C) or thermal (e.g., 67 C) radiofrequency ablation of the medial branch nerves to the facet joint should be performed for low back (medial branch) pain
- ONLY when previous diagnostic or therapeutic injections of the joint or medial branch nerve have provided temporary relief.
- Conventional radiofrequency ablation may be performed for neck pain
- Water-cooled radiofrequency ablation may be used for chronic sacroiliac joint pain.
- Conventional or thermal radiofrequency ablation of the dorsal root ganglion **should not be routinely used** for lumbar radicular pain.

Interventional Approaches to Pain Management

- Target the neural structures that are presumed to mediate the experience of pain
- Offer rapid, potent, local control of pain
- Reduced systemic side effects
- Each technique has specific risks
- These relate to local anatomy therapeutic mechanism of action

Facet (Zygoapophyseal)Joint

- Possible anatomic source low back pain by Ghormley in 1933
- Nerve supply medial branch from the posterior ramus of spinal nerve root
- ***However*** large-scale radiologic studies confirm that arthritic changes in these joints common in asymptomatic patients

- 1963, Hirsch showed
- Pain in the back and upper thigh
- Reproduced by injecting 11% hypertonic saline in the region of the facet joint
- 1970s
- Treatment success with radiofrequency denervation of the medial branches

Lord and colleagues

- Minimum of 50% reduction in pain intensity for 263 days in the active treatment group
- 8 days in the placebo group

Percutaneous radio-frequency for chronic cervical zygapophyseal-joint pain. Lord SM, Barnsley L, Wallis BJ, et al. N Engl J Med 1996;335:1721–6

Van Kleef and colleagues

- 50% reduction in pain, or more than two-point reduction on numeric rating scale
- Compared with placebo in those patients with at least 1 year of chronic low-back pain

Randomized trial of radiofrequency lumbar facet denervation for chronic low back pain. Van Kleef MV, Gerard AM, Barendse, et al. Spine 1999;24:1937–42

PRINCIPALS OF RADIOFREQUENCY ABLATION(RFA)

- High-frequency alternating current
- Moves from tip of an electrode into the tissue
- Current causes the ions in the tissue to change direction
- Causes friction, and heat is generated
- Greater than 60C-> cell death

PHYSICS OF RADIOFREQUENCY ABLATION(RFA)

- RFA causes coagulative necrosis at the targeted lesion
- It is not the probe that emits heat but the cells themselves
- Size of tissue lesion is proportional to the square of the RF current
- Tissue temperature decreases rapidly with increasing distance from the electrode
- Relatively uniform zone of radiant/ conductive heat within the first few millimeters

Continuous

- constant output of high-frequency electric current to produce temperatures of 45 C
- *'neuroablative thermocoagulation'*
- lasting inhibition of evoked synaptic activity

Pulsed RF (PRF)

- Brief "pulses" of high-voltage RF-range (<300 kHz) electric current
- voltage fluctuations in the tissue to be treated
- *NO tissue coagulates*
- transient inhibition of evoked synaptic activity

MODE OF ACTION

- Only transient sensory loss in the relevant dermatome is observed??????????
- Pain relief may be of much longer duration
- Electric field->neuromodulatory effect on pain processing mechanisms
- Dorsal root ganglion ,dorsal horn, and molecular levels
- Changing gene expression in pain-processing neurons

- Van Zundert et al
- RF interventions, both pulsed and continuous
- Similar increases in the number of cfos expressing cells (implies increased neuronal activity)
- Evidence for sustained activation of some pain-inhibiting mechanism

Hypothesized.....

PRF might produce prolonged analgesia by inhibiting excitatory C-fibers via long-term depression.

Pulsed and continuous radiofrequency current adjacent to the cervical dorsal root ganglion of the rat induces late cellular activity in the dorsal horn.Van Zundert J, de Louw AJA, Joosten EAJ, et al. Anesthesiology.2005;102:125–131

Why pulsed RF for new indications ?

- Tissue is not destroyed, it may be safer
- Avoiding destruction of other sensory neurons and motor neurons
- Efficacy in controlling pain without actually destroying tissue
- Requires less precision in the placement of electrodes
- Faster to perform

Evidence.....

- Level 2&3 clinical evidence has been obtained
- Pulsed radiofrequency treatment of the lumbar medial branch for facet pain—A retrospective analysis. Lindner R, Sluijter ME, Schleinzer W. Pain Med 2006;7(5):435–9
- Pulsed radiofrequency denervation for the treatment of sacroiliac joint syndrome. Vallejo R, Benyamin RM, Kramer J ,et al. Pain Med 2006;7(5):429–34

Table 1. Summary of the Randomized Controlled Trials on (Pulsed) Radiofrequency

Trial	Indication	Treatment	Follow-Up (months)	Outcome	Remarks
Lord 1996[12]	Cervical radicular pain after whiplash injury	RF facet $n = 12$ Sham $n = 12$	7	Time for pain to return to preintervention level RF 263 days Sham 8 days	Double-blind, placebo-controlled diagnostic blocks
Stovner 2004[19]	Cervicogenic headache	RF facet $n = 6$ Sham $n = 6$	1: 3: 6: 12, and 24	RF improvement after 3 months Sham no improvement	24 months after intervention both groups equal
Haspeslagh 2006[20]	Cervicogenic headache	RF facet + RF DRG $n = 15$ Local injection of GON + TENS $n = 15$	2: 4: 6, and 12	VAS, GPE, QoL no sign difference between both groups	1 year after intervention both groups equal
van Kleef 1996[17]	cervical radicular pain	RF DRG $n = 9$ Sham $n = 11$	2	VAS: McGill, MPI	Significant improvement in RF group
Slappendel 1997[21]	Cervical radicular pain	RF DRG 40°C $n = 32$ RF DRG 67°C $n = 29$	1.5 and 3	VAS	Both groups equal improvement
Van Zundert 2007[28]	Cervical radicular pain	PRF DRG $n = 11$ Sham $n = 12$	3	VAS: GPE, QoL, need for pain medication	3 months significant improvement VAS and GPE PRF group 6 months trend QoL better in PRF group Significant less need for pain medication in PRF group
van Kleef 1999[11]	Low back pain (facet pain)	RF facet $n = 15$ Sham $n = 16$	3, 6, and 12	VAS: GPE: ODI Sign improvement in RF at all time points	1 diagnostic block
Gallagher 1994[12]	Low back pain (facet pain)	RF facet $n = 24$ Sham $n = 17$	1 and 6	VAS: Mc Gill	Pts with improvement after diagnostic block sign improvement after RF Pts with equivocal response to diagnostic block no sign improvement
Leclaire 2001[14]	Low back pain (facet pain)	RF facet $n = 36$ Sham $n = 34$	1 and 3	4 w RM sign improved in RF group VAS and ODI no difference at 4 and12 w	Diagnosis: intraarticular facet injection, assessment by family doctor
van Wijk 2005[15]	Low back pain (facet pain)	RF facet $n = 40$ Sham $n = 41$	3	VAS improved in both groups ODI sign better in RF	It is suggested that the needles were not correctly placed, therefore the RF treatment might have been a sham intervention
Tekin 2007[16]	Low back pain (facet pain)	RF facet $n = 20$ PRF facet $n = 20$	6 and 12	VAS and ODI: RF longer lasting pain relief	
Geurts 2003[18]	lumbar radicular pain	RF DRG $n = 45$ Sham $n = 38$	3	Multidimensional rule VAS back and leg Physical impairment	
Erdine 2006[13]	Idiopathic trigeminal neuralgia	RF Gasserian ganglion $n = 20$ PRF Gasserian ganglion $n = 20$	3	VAS and PSS	RF better than PRF

DRG, dorsal root ganglion; GON, greater occipital nerve; GPE, global perceived effect; MPI, Multidimensional Pain Inventory; ODI, Oswestry Disability Index; PRF, pulsed radiofrequency; PSS, pain severity scale; QoL, quality of life; RF, radiofrequency; TENS, transcutaneous electrical nerve stimulation; VAS, visual analog scale.

Pulsed Radiofrequency of the Median Nerve under Ultrasound Guidance

- Carpal tunnel syndrome = *Neuropathy of the median nerve*
- Age adjusted incidence of 105 cases per 100,000 person years
- Recurrent symptoms occur in 0% to 19% of patients following release
- Prognosis for re-exploration is not good

Naeem Haider, Daniel Mekasha, Srinivas Chiravuri, Ronald Wasserman. Pain Physician 2007; 10:765-770

- Diagnostic median nerve block at the cubital fossa
- Pulsed RFA of the median nerve performed on the left side at the cubital fossa
- Multiple pulsed treatments at anatomically distinct sites
- 70% reduction in pain (follow up period of 12 weeks)

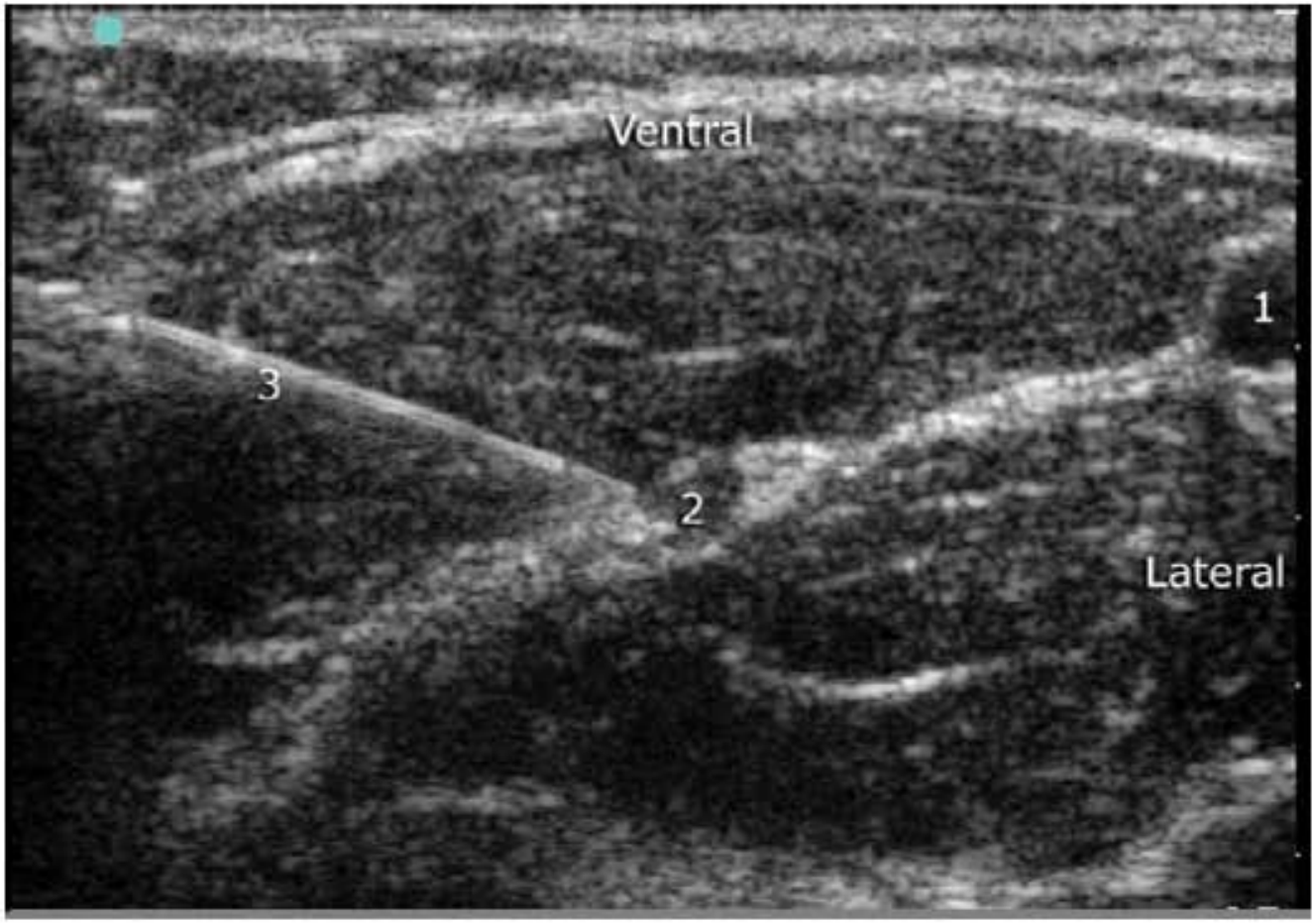


Fig. 1. *Cross section of left cubital fossa using 12 mHz, 38 mm ultrasound probe demonstrating brachial artery (1) and median nerve (2).*

Details

- EMG bilateral carpal tunnel syndrome
- Skin was pink, cool, and dry, with no evidence of hyperesthesia or allodynia. Normal hair and nail distribution
- 54 mm RF probe with a 4 mm active tip
- PRF was at a temperature of 42 Celsius for 90 seconds
- 3 lesions under direct guidance

A Case Series of Pulsed Radiofrequency Treatment of Myofascial Trigger Points and Scar Neuromas

- PRF was used to treat and neuromatous pain
- Evaluated retrospectively for technique, efficacy, and complications
- 9 patients were treated over an 18-month period
- All had longstanding pain ,refractory to medical management, physical therapy and trigger point injections

Mazin Al Tamimi, Michael H. McCeney and Jason Krutsch. PAIN MEDICINE Volume 10 • Number 6 • 2009.doi:10.1111/j.1526-4637.2009.00646.x

Treatment

- 21- or 22-gauge 50-mm straight tipped cannula with a 4-mm active tip
- LA skin infiltration
- Cannula was advanced until pain was reproduced
- Sensory stimulation performed at 50 Hz
- To reproduce pain and rule out contact with a larger peripheral nerve
- Treatment - 20ms bursts at 2 Hz for 240 seconds
- Voltage to prevent active tip temperature from exceeding 42 C.

Table 1 Summary of results of pulsed radiofrequency treatment for myofascial trigger points and scar neuromas

Patient	Age (Years)	Sex	Diagnosis	Previous Therapies	Number of PRF Points*	Degree of Benefit	Duration of Benefit
1	26	F	1. Abdominal pain 2. Myofascial abdominal wall pain	Botox	2 (iliohypogastric region)* ×1 on July 27, 2006	>50%	>6 months
2	71	M	1. Sacroiliitis 2. Myofascial pain 3. Lumbar spondylosis	SI injections and PRF of sacral lateral branches, Botox, Medial branch block and PRF, TPI	3 parasacral points ×4*	>50%	4–6 weeks relief
3	55	F	Fibromyalgia	TPI; 1 month relief	5 PRF* ×1	50%	>6 months in treatment area but persisting diffuse myofascial pain
4	62	M	1. Stump neuroma 2. Phantom limb pain	TPI; temporary relief	6 PRF ×1	100%	>1 year
5	42	F	1. Neck pain 2. Upper extremity pain 3. Cervical DJD 4. Myofascial pain	Multiple TPI; 3 weeks relief	6 PRF ×1	70%	>9 months
6	28	F	1. Low back pain 2. Mild DJD 3. Myofascial pain	TPI ×5; 2 weeks relief	6 PRF paraspinus; 3 each side; repeat ×1 after 9 months	100%	9 months
7	55	F	Fibromyalgia	TPI ×6; 1 month benefit	6 PRF	>50%	1 month
8	66	M	1. Shoulder pain 2. Post shoulder arthroplasty 3. Myofascial pain	1. TPI ×3; 1 (1 week relief) 2. Peripheral nerve block ×2 (limited relief)	3 PRF	70%	>1 year
9	20	F	Subxiphoid myofascial pain	TPI ×4; 3 weeks relief	1 PRF; 2 cycles ×2	100%	6 months

* These treatments were followed by sterold injection.

M – male; F – female; TPI – trigger point infections; PRF – pulsed radiofrequency treatment; SI – sacroiliac joint; Botox – botulinum toxin A; DJD – degenerative joint disease.

- 8 out of 9 cases-75–100% reduction in their pain (4 week follow up)
- 6 out of 9 (67%) 6 months to greater than 1 year of relief
- One patient experienced no better relief when compared with trigger point injection
- Several patients experienced mild postprocedural tenderness and pain for 1–2 days
- ***Conclusion - Further systematic evaluation of this treatment approach is warranted***

Successful Treatment of Meralgia Paresthetica with Pulsed Radiofrequency of the Lateral Femoral Cutaneous Nerve

- Sensory mononeuropathy
- Paresthesia, pain or sensory impairment
- Lateral femoral cutaneous nerve (LFCN) distribution
- Entrapment or compression of the nerve as it crosses the anterior superior iliac spine (ASIS) and runs beneath the inguinal ligament

Cyril N. Philip, Kenneth D. Candido, Ninos J. Joseph, BS, George J. Crystal, PhD. Pain Physician 2009; 12:881-885•

Patient...

- 33-year-old morbidly obese female (BMI=41 kg/m2)
- History of lower back pain and previous spinal fusion
- Sensory dysesthesias and paresthesias in the right anterolateral thigh
- Temporary relief with multiple lateral femoral cutaneous nerve and fascia lata blocks
- Symptoms included severe burning and tingling dysesthesia in the distribution of the LFCN

- Hip extension and ambulation exacerbated these symptoms
- Presentation, the patient rated her pain as 9/10
- LFCN blocks with 5 mL bupivacaine 0.5% and methylprednisolone 40 mg were effective
- However.... pain relief was only temporary,lasting 2 weeks or less

Treatment

- Area above ASIS was located fluoroscopically
- 1 centimeter medial and cephalad to the ASIS using 2 mL lidocaine1%
- 20-gauge, 15 cm radiofrequency
- Cannula with a 10 mm active tip was inserted to 12cm
- Sensory stimulation at 0.47 mA
- Confirmed proper localization of the RF electrode.
- Motor stimulation was negative at 2 V
- PRF
- 42 C
- 120 seconds.

- 1 mL of 0.5% bupivacaine and dexamethasone 4 mg post treatment
- 9-month follow-up, the patient reported no return of symptoms
- Rated her pain as 0/10
- Discontinue her use of hydrocodone, pregabalin, and celecoxib
- Lost 25 pounds post procedure, due to her increased activity

Pulsed Radiofrequency Under Ultrasound Guidance for Persistent Stump-Neuroma Pain

Phantom complex comprises three elements:

i. phantom limb sensation;
ii. phantom limb pain;
iii. stump pain

Carlos E. Restrepo-Garces, Anton Marinov, Paul McHardy et al. Pain Practice, Volume 11, Issue 1, 2011 98–102

History

- Previous open fracture of the tibia (Gunshot)
- Amputation general anaesthetic
- Post-op severe pain at incision 7-8 weeks
- New pattern of symptoms was observed by the patient
- Paraesthesic and shooting pain from posterior mid-thigh to the most caudal point of the stump
- VAS score consistently 6/10 at night
- Increasing to 10/10 while wearing the prosthesis

Examination

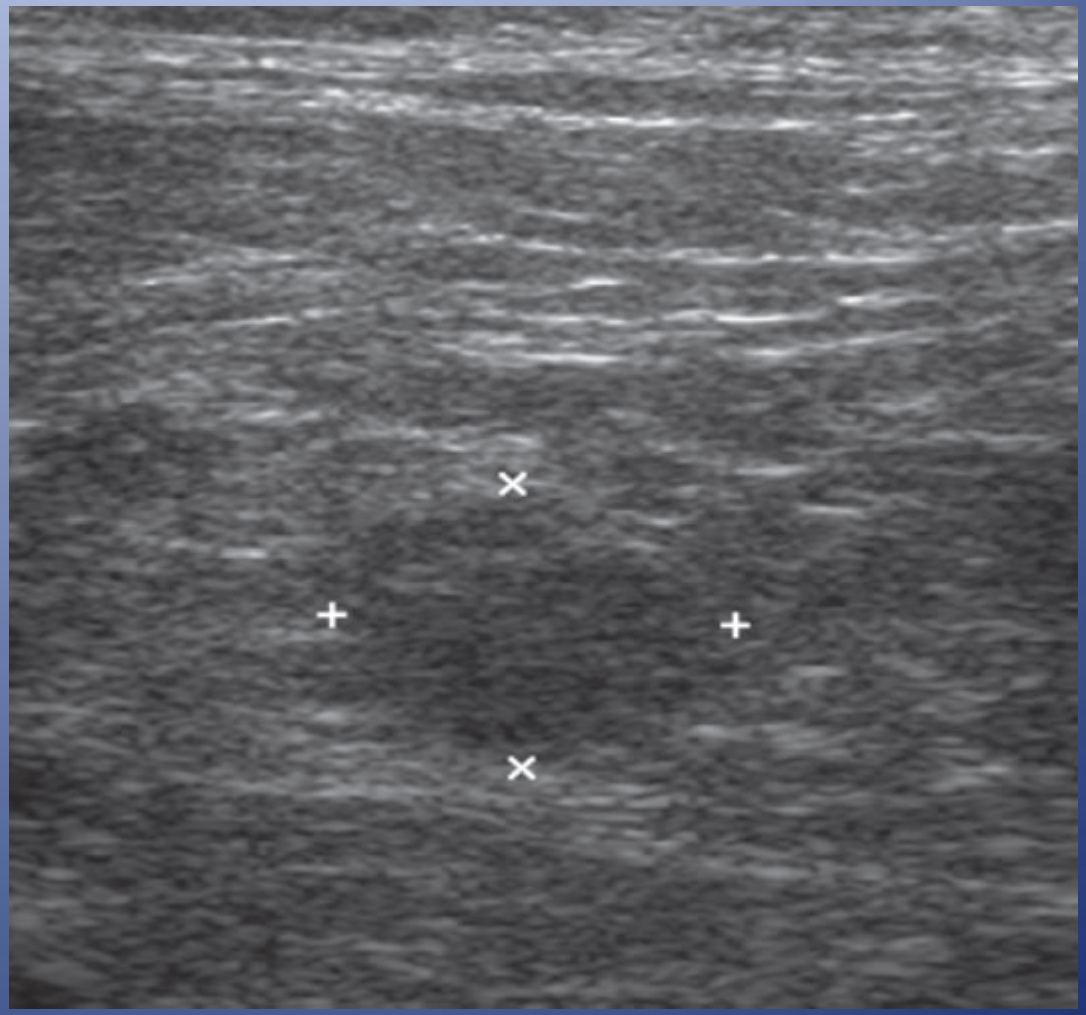
No residual infection

No mechanically or thermally induced allodynia.

Tinnel's sign between the insertion of the biceps femoris and the semimembranosus tendons, 4 cm above the popliteal crease.

Ultrasound scan of the popliteal fossa and above

showed a mass in the sciatic nerve pathway, 0.5 x0.8cm



- Stump pain interference with proper prosthetic use
- Diagnosis of neuroma is principally a clinical one
- Imaging (such as ultrasound) can help with diagnosis
- Therapy includes;

  pharmacological treatment,

  interventional pain procedures and

  surgery

Procedure

- Diagnostic block
- Postprocedure VAS showed a decrease of 85%
- 10 cm, RF cannula a 5 mm active tip
- Positioned just outside the neuroma
- Sensory stimulation reproduced the patient’s symptoms at 0.3–0.4 mA
- 2 mL of levobupivacaine 0.75% and 10 mg of triamcinolone were injected
- 2 pulsed radiofrequency lesions at 42 C for 120 seconds in the proximal and distal ends of the neuroma

- Compared with the baseline VAS (8/10),
- there was a decrease of 90%, 90%, and 70% at 1, 3, and 6 months, respectively

Radiofrequency treatment relieves chronic knee osteoarthritis pain:A double-blind randomized controlled trial

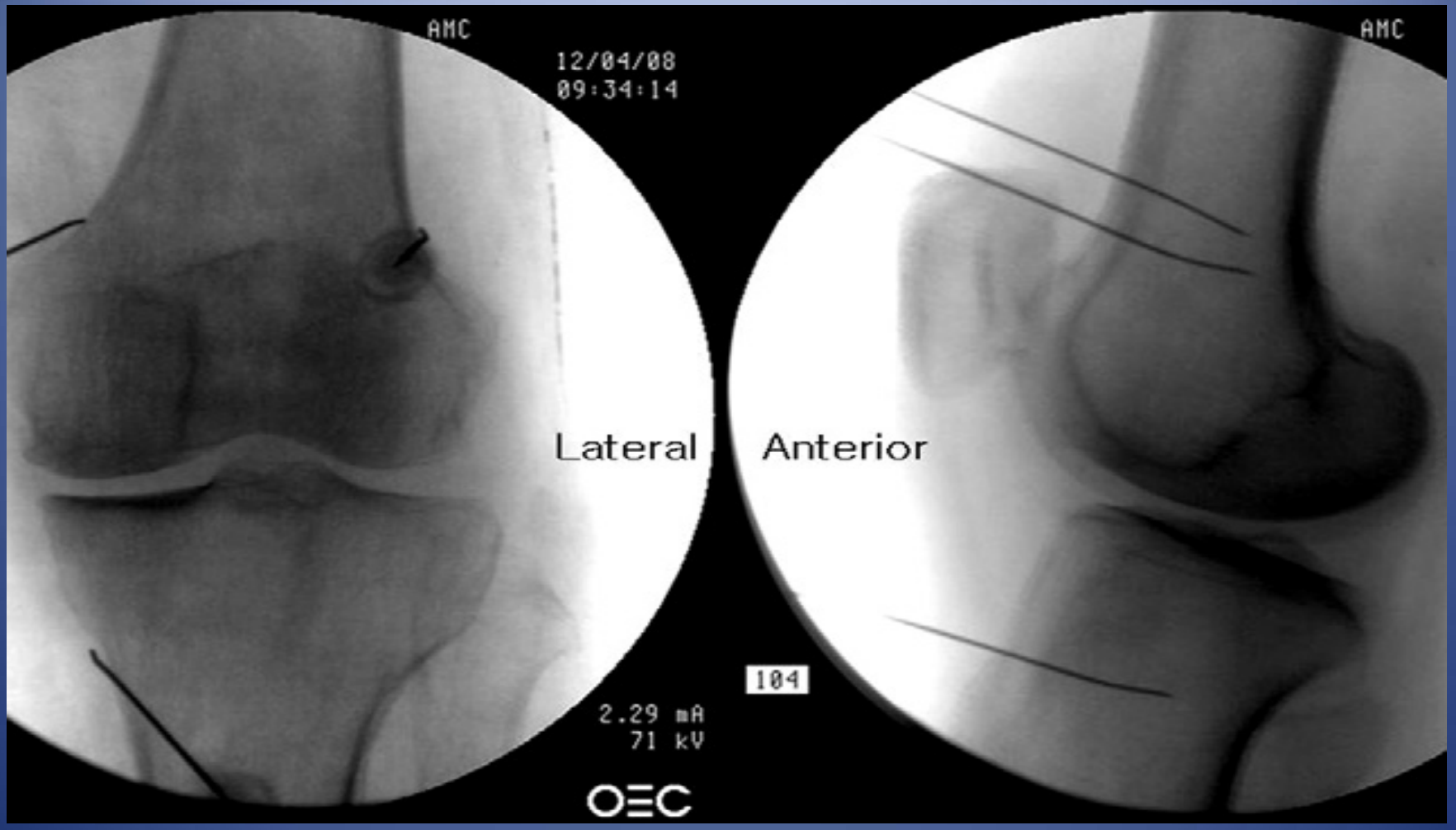
- Diagnostic genicular nerve blocks under fluoroscopy
- Genicular nerves consist of the superior lateral (SL), middle, superior medial (SM), inferior lateral (IL), inferior medial (IM), and recurrent tibial genicular nerve [**Total =6**]

  Targets;
- SL, SM and IM genicular nerves
- Pass periosteal areas connecting the shaft of the femur to bilateral epicondyles and
- Shaft of the tibia to the medial epicondyle
- Responses positive if decrease in numeric pain scores of at least 50% for more than 24 h.

Woo-Jong Choi , Seung-Jun Hwang , Jun-Gol Song et al. doi:10.1016/j.pain.2010.09.029

Technique

- 10 cm 22-g RF cannula ,10 mm active tip
- Fluoroscopic guidance (True AP)
- Towards areas connecting the shaft to the epicondyle
- Sensory stimulation at 50 Hz to identify the nerve position
- Less than 0.6mV
- Nerve was tested for the absence of fasciculation in the corresponding area
- Stimulation of 2.0 V at 2 Hz



Fluoroscopic image of anteroposterior and lateral views of the left knee joint. RF electrode tips were placed on periosteal areas connecting the shaft of the femur to bilateral epicondyles and the shaft of the tibia to the medial epicondyle. Superior medial, superior lateral and inferior medial genicular nerves run down these areas.

- Tip temperature was raised to 70 C for 90 s
- One RF lesion for each genicular nerve
- Outcome measures were assessed at baseline and at 1, 4, and 12 weeks
- **Primary outcomes** ;

i. mean changes from baseline knee pain as measured by VAS at 1, 4, and 12 weeks

ii. proportion of patients achieving at least 50% knee pain relief

Secondary outcomes;

i. Functional changes,
ii. Patient satisfaction with treatment
iii. Incidence of adverse effects

Results

In the RF group, VAS knee pain scores were lower at all post-procedure assessment points compared with baseline ($p < 0.001$)

*2 patients in the RF group (12%)

achieved poor or no response to RF neurotomy*

Pulsed Radiofrequency of the Sural Nerve for the Treatment of Chronic Ankle Pain

- 39-year-old female sharp ankle pain after a fall
- Constant, sharp, and aching
- No response to NSAIDs, hydrocodone, and acetaminophen
- Pain at rest as 3/10 & activity 7/10
- Right sural nerve block (5mL 0.25% bupivacaine and 20 mg of triamcinolone)
- Short lived relief

Lyudmil Todorov,. Pain Physician 2011; 14:301-304

Procedure

- 3 months post injury underwent a PRF application to the sural nerve
- 22-gauge, 10 cm RF cannula 10 mm active tip
- Sensory stimulation to identify sural nerve at 0.4 volts and 50Hertz
- PRF application for 240s ,45 V ,not more than 42 C
- 5 mL of 0.25% bupivacaine and 20 mg triamcinolone post RF
- Five months post-procedure ->no pain in the ankle.

Hamilton Pain Management Centre

- Recently we have seen 4 patients who are being considered for trials of peripheral PRF
- 2 staff regularly use PRF for peripheral ‘lesioning’
- Includes – post inguinal herniorraphy pain, facial(supraorbital) pain
- Awaiting radiology time for 2 knee pain patients and 1 ulnar nerve to be assessed and treated
- Trial of median nerve PRF in resistant CRPS in the hand (Traumatic amputation)

In Conclusion....

RF in the management of chronic pain is a useful tool;

- ✓ Its minimally invasive character, target-selective approach
- ✓ The possibility of outpatient treatment
- ✓ The relatively low incidence of side effects and complications—(if carried out by a well-trained pain physician in the right setting)
- ✓ These reasons justify its use in patients refractory to conservative management
- ✓ The development of PRF, may open new and broader perspectives for RF treatment.

References.

- Radiofrequency neurotomy for the treatment of third occipital headache. J Govind, W King, B Bailey, N Bogduk. J Neurol Neurosurg Psychiatry 2003;74:88–93
- Radiofrequency Procedures. G. B. Racz, R. Ruiz-Lopez, Pain Practice, Volume 6, Issue 1, 2006 46–50.
- Pulsed Radiofrequency Treatment: What Is the Evidence of Its Effectiveness and Should It be Used in Clinical Practice? Rollin M. Gallagher. PAIN MEDICINE Volume 7 • Number 5 • 2006.
- Pulsed Radiofrequency of the Median Nerve under Ultrasound Guidance. Naeem Haider, Daniel Mekasha, Srinivas Chiravuri, Ronald Wasserman. Pain Physician 2007; 10:765-770.
- Radiofrequency and Pulsed Radiofrequency Treatment of Chronic Pain Syndromes: The Available Evidence. Koen van Boxem, Maarten van Eerd,Tjinta Brinkhuize et al. Pain Practice, Volume 8, Issue 5, 2008 385–393
- Radiofrequency treatment relieves chronic knee osteoarthritis pain: A double-blind randomized controlled trial. Woo-Jong Choi , Seung-Jun Hwang , Jun-Gol Song et al. doi:10.1016/j.pain.2010.09.029

- Pulsed Radiofrequency of the Sural Nerve for the Treatment of Chronic Ankle Pain. Lyudmil Todorov,. Pain Physician 2011; 14:301-304
- Pulsed Radiofrequency Under Ultrasound Guidance for Persistent Stump-Neuroma Pain. Carlos E. Restrepo-Garces, Anton Marinov, Paul McHardy et al. Pain Practice, Volume 11, Issue 1, 2011 98–102.
- A Case Series of Pulsed Radiofrequency Treatment of Myofascial Trigger Points and Scar Neuromas. Mazin Al Tamimi, Michael H. McCeney and Jason Krutsch. PAIN MEDICINE Volume 10 • Number 6 • 2009.doi:10.1111/j.1526-4637.2009.00646.x
- Successful Treatment of Meralgia Paresthetica with Pulsed Radiofrequency of the Lateral Femoral Cutaneous Nerve. Cyril N. Philip, Kenneth D. Candido, Ninos J. Joseph, BS, George J. Crystal, PhD. Pain Physician 2009; 12:881-885•
- Pulsed Radiofrequency Treatment of Lower Extremity Phantom Limb Pain. Denise Wilkes, Natalie Ganceres, Daneshvari Solanki, Maureen Hayes. Clin J Pain Volume 24, Number 8, October 2008.
- Musculoskeletal Interventional Radiology:RadiofrequencyAblation. EmilyWard, Peter L.Munk, Faisal Rashid, William C.Torreggiani. Radiol Clin N Am 46 (2008) 599–610. doi:10.1016/j.rcl.2008.02.006

- Practice Guidelines for Chronic Pain Management - An Updated Report by the American Society of Anesthesiologists Task Force on Chronic Pain Management and the American Society of Regional Anesthesia and Pain Medicine. Anesthesiology 2010; 112:810 –33.
- Interventional Approaches to Pain Management. John D. Markman, Annie Philip. Anesthesiology Clin 25 (2007) 883–898
- Randomized trial of radiofrequency lumbar facet denervation for chronic low back pain. Van Kleef MV, Gerard AM, Barendse, et al. Spine 1999;24:1937–42
- The utility of comparative local anaesthetic blocks in the diagnosis of cervical zygapophysial joint pain. Lord SM, Barnsley L, Bogduk. Pain 1993;18:343–50.
- Percutaneous radio-frequency for chronic cervical zygapophyseal-joint pain. Lord SM, Barnsley L, Wallis BJ, et al. N Engl J Med 1996;335:1721–6.